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Combined use of meio- and macrobenthic indices to assess complex chemical impacts on a stream ecosystem

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Ecosystem dynamics (e.g. temperature, inorganic nutrients) and properties (e.g. resilience, robustness), and ecological functions and services depend on the structure and diversity of biological communities, and the fluxes of energy and materials occurring within and across abiotic and biotic boundaries. The close interchange, i.e. multiple feedback loops, between hydrologic and biologic controls is also becoming increasingly evident. Holistic approaches are thus necessary for a robust understanding of ecosystem functioning and subsequent implementation of effective management practices across multiple spatial scales.

Groundwater and surface water resources are under pressure from increasing global exploitation and anthropogenic impacts such as contamination by chemicals, leading to a severe degradation of essential ecological functions. Many of the environmental problems we face today have existed for decades; what has changed is our understanding of the key drivers, processes and impacts. The first reporting by European Member States (MS) on the status of their water bodies found that rivers and transitional waters were often in worse condition than lakes and coastal waters. This is not surprising considering that streams integrate all of the diverse stressors found within a catchment (e.g. contaminated sites; diffuse source pollution; water abstraction).

The chemical status of a water body is relatively straightforward to assess, defined partly by environmental quality standards on priority substances and partly by additional regulations imposed by individual MS. However, the biological quality elements used for the classification of ecological status are only loosely defined, leaving MS free to develop their own assessment tools. Although useful for the individual MS, it impedes methodological standardization across different ecoregions, thus contributing to inconsistencies and data gaps across Europe. Moreover, despite the unambiguous importance of benthic habitats for overall ecosystem health, many biological indices tend only to reflect the ecological quality of surface water, rather than of the sedimentary zones where the accumulation of pollutants is often highest.

To address this issue, we monitored meiobenthic (i.e. nematodes) and macrobenthic invertebrate communities along a pollution gradient in order to assess the impact of multiple stressors on a groundwater-fed stream, and thus quantify the link between chemical and ecological status. The studied stressors included point source pollutants originating from contaminated groundwater and aquaculture, and diffuse source pollutants originating from conventional agriculture and urban areas. The use of macrofauna is now well-accepted for assessing ecological integrity in aquatic ecosystems, but less is known about the application of meiofaunal community indicators. High abundance and ubiquitous distribution are two potential advantages for including meiofaunal indicators, and notably – for the case of groundwater-surface water interactions – they are particularly suitable for identifying changes in environmental conditions over smaller spatial scales. The results indicate a change in community composition for both meio- and macrobenthic fauna, pointing towards the presence of a local impact resulting from the discharging contaminated groundwater, which extends downstream along a dilution gradient of the groundwater contaminants. Ecological impacts could be linked to xenobiotic compounds coming from groundwater (both chlorinated solvents and pharmaceuticals), as well as the presence of trace metals of diffuse and/or biogenic origin.